

A Survey of Jarak Island, Straits of Malacca

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Plates 5 and 6

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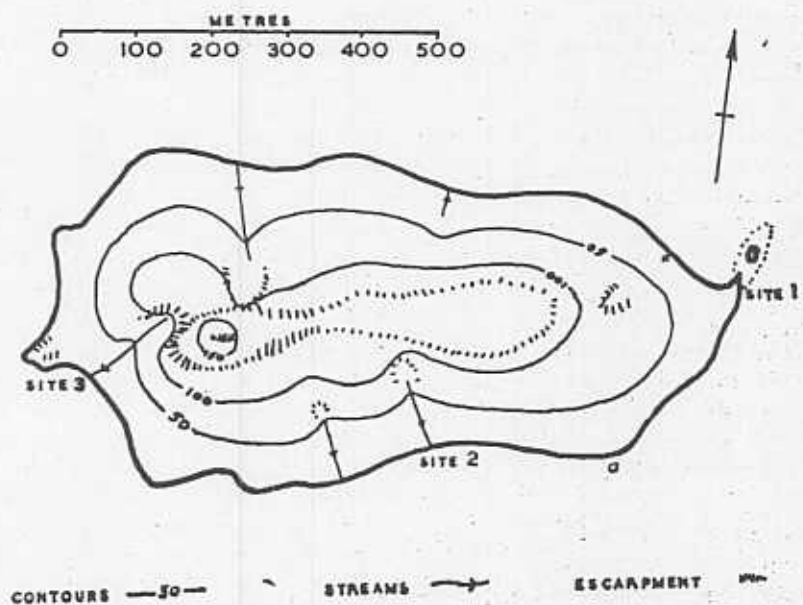
INTRODUCTION

Jarak is a small uninhabited island in the middle of the Straits of Malacca and about equidistant from Penang and Port Swettenham. It is sited at 3° 59'N and 100° 6'E, about 40 miles from the coast of Perak and 30 miles from the group of Sembilan Islands which lie near the mouth of the Perak River, the biggest of the Malayan rivers. A museum expedition to this island in 1932 led to an outbreak of scrub typhus (Audy 1949); and for this reason it was visited for ten days in January 1950 by a party from the Scrub Typhus Research Unit, which is studying the ecology of the vector mite and its hosts. Mr. Wyatt-Smith, Forest Botanist, accompanied the expedition.

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The Structure of the Island

The island is roughly half a mile long and a quarter broad and appears to rise steeply from the sea. It is surrounded by a fringe of shallow water, extended to the north-east by reefs. The beach is everywhere narrow, and in most parts is completely obliterated by the fringe of giant boulders (Plate 5). At the extremities of the long axis of the island the beach is fairly well developed. From the shore the land everywhere rises steeply with a slope of 30° or more to a central flat-topped ridge with the highest point (508 feet = 155 m.) at the west end, referred to as "High Point" (Map, Fig. 1). At the foot of the slope an obvious scree of large boulders is bound together with tree roots and the interstices are filled with undecomposed leaf litter and peaty soil. Higher up the slope and on the ridge there are frequent boulder outcrops but most of the terrain is covered with soil which is frequently washed away exposing a network of tree-roots. The whole island is covered with forest with little undergrowth, and, as plate 5 shows, the vegetation cover is complete right down to the boulders which are washed by the sea.



A sketch map of Jarak Island

Fig. 1. Approximate only, Estimated contours at 50 m. vertical interval.

A number of streams arising some half way up the slope have cut shallow gorges which are heavily cluttered with boulders. In view of the large size of the boulders it was not easy to decide if any bedrock was exposed. All the boulders examined were of a coarsely crystalline rock, presumably granite, as is recorded by Scrivenor (1931), but no expert examination was made.

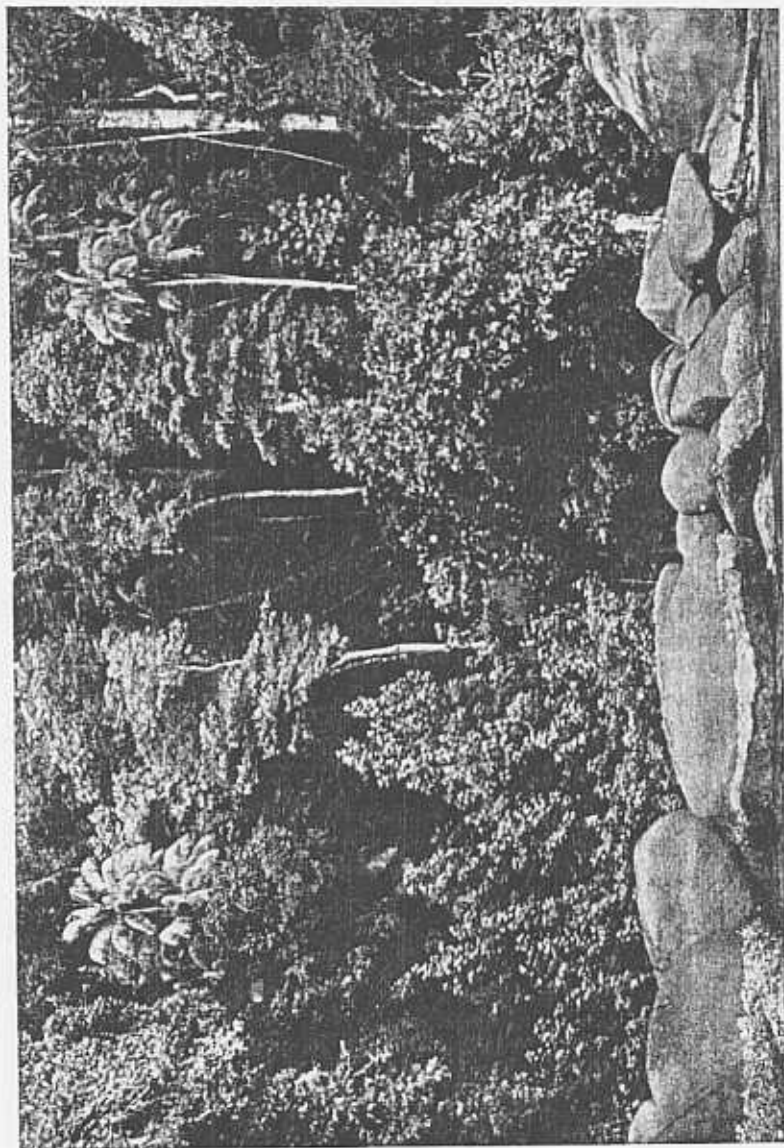
Early History

Jarak is shown as *Ch'en Kung Hsu*, Master Ch'en's island, in the *Wu Pei Chi* charts of the 15th century Chinese admiral Cheng Ho, which appear to have been copied from earlier Arab versions (Mills 1937). Douglas (1949) states that Ch'en Tsu was a powerful pirate chief who had his headquarters in Palembang, Sumatra, at the end of the 14th century. Master Ch'en's Island, Douglas suggests, is so named because, commanding as it does a view across the whole central part of the Malacca Straits, it was probably used as a base or a lookout from which the pirates could intercept shipping. *Jarak* is a Malay word meaning intervening space, although it is more commonly known as a name for several purgative plants. Dato Douglas has told us of two other names; the current Chinese one of *Pak Ku*, the northern turtle; and a Malay name *Temurah* probably from the word meaning to meet, i.e. "midway island".

Recent History

Except that the island must always have been a useful landmark to sailors, and that it has doubtless been known as a source of fresh water and as a useful windbreak for small fishing vessels, there is no link to be found bridging the five centuries after Master Ch'en until recent scattered records appear of five or six collecting visits to the island. There appears to be no proper account of these visits and a good deal of our information comes from Mr. Ben Ensoll, collector to the Selangor Museum, who accompanied the last two expeditions and himself fell ill with scrub typhus.

The first recorded visit was in December 1904 by H. C. Robinson, the then newly appointed Curator of the Selangor Museum, who obtained several specimens of a rat, one of which was sent to Bonhote and described as *Mus jarak* Bonhote, 1905. In April 1915 it appears that, in the course of a collecting cruise in the Straits, 'two natives' were landed on Jarak and collected over a hundred skins and skulls of the rats, which were studied by Robinson (1916). In November 1919 a collecting party stayed on the island. The only published record seems to be a list of 29 birds prepared by Robinson and Kloss



Survey of Jarak Island (Audy, Harrison and Wyatt-Smith).



Survey of Jarak Island (Audy, Harrison and Wyatt-Smith).

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(1922) who were responsible for the expedition. Material in the herbarium of the Forest Research Institute, Kepong (see below) suggests that a forester accompanied them.

According to the Report of the F.M.S. Museums Department (1922) a botanical visit was made in 1921 by or at the instigation of Mr. H. L. Hume:

'Additional collections of plants were also made on Kedah Peak, . . . and on Pulau Jarak, a small island about 30 miles to seaward of the Dindings. The latter collection will prove specially interesting as the island is uninhabited and but rarely visited and the vegetation therefore represents the original primitive flora almost uninfluenced by extraneous conditions.'

The next visit is ill recorded. According to the annual report of the F.M.S. Museums, Mr. E. Seimund, Technical Assistant, collected hundreds of sea-fish in March 1926 off the Sembilan Islands (Rumbia and Lalang). Mr. Ensoll states that 'about March or April 1924, between the Gunong Tahan and the Cameron Highlands expeditions' a party comprising Mr. Seimund, Mr. Long (or ? Mr. Hume) and Messrs. Ensoll, Chandi Jemad, Lee Mok Sai, and Beeti, stayed on Jarak for some three weeks collecting fish and other specimens. They camped first at site 1 (Map. fig. 1) where their motor boat was damaged against the rocks. They then moved round to site 2 which was more sheltered. About ten coconuts, brought by them, were planted along the beach. Mr. Ensoll distinguishes between this 1924 visit and the 1926 visit to the Sembilan Islands. He is not sure but he thinks that one or two members of the party were taken ill after the expedition.

The next and last visit was between March and May 1932. According to the Museums department report, 'the purpose . . . was to secure specimens for the Museum of some of the larger marine fishes which are known to abound in the coral reefs'. Mr. Ensoll states that there were about eight members, Mr. Seimund, and Messrs. Suleiman (who collected insects,) Ensoll, Abdul Latiff, Pundisamy, Bana, and two boatmen Ahmad and Ismail. They camped for about three weeks at site 3, where the boat could be drawn right up on to the beach. Towards the end of their stay they amused themselves by shooting all the rats which came into the camp by night. They made a competition of this, and the dead rats were piled up near each competitor's bed to be counted and thrown into the sea in the morning. According to Mr. Ensoll this took place for four or five days and each competitor scored up to two or three hundred rats during the period. If this account, recalled after a lapse of over 15 years, is accurate, then over a thousand rats were shot in the camp area in a few days. In any case the game of piling up dead infested rats at the bedside, and of clearing the camp of

the natural host of the vector larvae may have been responsible for the sequel to the visit, for all but two members of the party (Abdul Latif and Bana) apparently became infected with scrub typhus. At least one of the party became ill while on the island, and Ensoll himself was admitted to hospital on the day after his return. These early infections, however, must have been contracted before the shooting episode.

Mr. Ensoll reports that during this visit rats and land-crabs were numerous, a number of sea-eagles were present, but there were no squirrels, monkeys, or snakes. More coconuts were planted, the first lot having either failed to establish themselves or having been cut down by visiting fishermen. He also says that a tin of opium was found, presumably a smugglers cache, and was thrown into the sea by the leader of the party.

The only other visitors of whom there is any trace are the unknown surveyors who determined the height of the island as 508 feet. At the highest point is a small knoll, perhaps 30 m. in diameter, on which the trees all appeared unusually young. It is likely that the area was cleared for survey purposes. It was after sitting in this area in 1932 that Mr. Ensoll complained of being attacked by *tungau* (scrub-itch). He describes the area at that time as being much more open and as commanding a wide view, which at present it does not.

The Present Expedition

On the present occasion the party spent the last ten days of January 1950 on the island. We are grateful to Mr. R. S. B. Unwin, Marine Superintendent, for arranging transport to and from the island in the M. V. Sirius, and for a visit by the vessel half way through the stay. The party consisted of ten, the three authors Mr. Ensoll, three assistants from the Scrub Typhus Research Unit (including a cook) one assistant from the Malaria Research Division of the Institute for Medical Research, and two assistants from the Forest Research Institute. Several possible camp sites were reconnoitred, site 1 seemed most attractive, but the water supply was poor, site 3 seemed too damp for the safety of plant specimens, so site 2 was chosen at the side of a stream.

Fairly elaborate precautions were taken in the form of clothing impregnated with Dibutyl Phthalate, but sanitary discipline was not good and only too often assistants who had been taught, warned, and even threatened, were found to be exposing themselves in untreated or incomplete clothing. However no-one developed scrub-typhus. Four members of the party had experienced scrub typhus before (including Mr. Ensoll) and possibly had some immunity, although recent investigations have

shown that one attack of the disease by no means ensures protection from subsequent attacks. Rats were encouraged in the camp area, and it seems likely that such an efficient host of the vector mite protected the party by collecting any free infected larvae.

At the time of our arrival, a small Chinese motor vessel was fishing off the island. It soon left but another appeared in a few days. This second vessel, which was from Singapore, stayed for several days and seemed to get good hauls. Another vessels was seen, and a subsequent air-photographs showed a similar vessel fishing in the same locality. It seems therefore that there was plenty of fishing off the island, but none of the crews seemed to show any desire to land. Indeed although we exchanged gifts of tinned fruit and chocolate for fresh fish, no one came beyond the rocks of the beach. Whether or not the island had a bad reputation among the fishermen we could not determine.

A more detailed account of the visit is given in the *Malayan Nature Journal* (Audy 1950).

Notes on the Vegetation

By J. WYATT-SMITH

Previous expeditions to Jarak have been primarily zoological, and although small collections of plants were made by Seimund about 1920 (material in herbarium of the Botanic Gardens, Singapore), and by Forester Hamid in November 1919 (material in herbarium of Forest Research Institute, Kepong) nothing about the flora was published.

It is not the intention in this short note to give a detailed description of the flora and of the ecological work done during the ten day visit, not will the phyto-geographical interest of the flora be discussed. It is hoped that these will be published later in the *Journal of Ecology*.

The first impression of Jarak, on approaching it from the sea, was of a jungle-covered hill shaped like a camel's hump, and rising sheer out of the sea with large rocky boulders at the water's edge. This is no fantasy, for except for a small spit at the NE end of the island and the ridge top no flat land exists.

My immediate reaction to the forest on landing was the paucity of the shrub and lower tree-storey layers and the apparent dryness of the soil due possibly to very good drainage caused by the burrows of the giant land crabs. The vegetation

was not typical tropical rain forest, which was what I was expecting, with a mixture of Malay Peninsula and Sumatran species.

Of the species recognised immediately were *Pandanus fascicularis* Lam. (mengkuang), *Hibiscus tiliaceus* L. (bebaru) growing by the mouth of a stream and overhanging the boulders by the sea's edge (Plate 5), *Barringtonia asiatica* Kurz (putat) which was very common along the water's edge, both the latter species were heavily in flower, *Eugenia grandis* Wight (jambu laut) and small clumps of the tree palm *Oncosperma filamentosa* Bl. (bayas) which formed a narrow belt along the coastal fringe behind the *Barringtonia*. On the slopes the most prominent and striking large trees were *Campnosperma auriculata* Hk. f. (terentang), *Tarrietia javanica* Bl. (mengkulang), a species of *Dysoxylum* (kulim), *Amoora* aff. *ridleyi* King (bekak), *Santiria laevigata* Bl. (kedondong), and *Kurrimia paniculata* Wall. All trunks of trees on the lower slopes of the island down to sea level, and on the sea-ward side of the bole were covered with the common swamp climbing fern, *Stenochlaena palustris* (Burm.) Bedd.; it would appear that its distribution is governed by the humidity of the air.

In addition to the common coastal species mentioned above single trees of *Terminalia catappa* L. (ketapang) and *Scaveola frutescens* (L) Krause, so typical of coastal fringe forest, were found on the NE tip of the island. At this spot there are also a few coconut trees, relics of previous scientific visits, coconut meat being used as bait in rat traps.

Common main to under storey trees are *Diospyros wallichii* K. & G. (tuboh buah), *Knema geminata* Warb. (penarahan), *Dracaena maingayi* Hk. f. (jenjulang) and *Bouea macrophylla* Griff. (kudang hutan).

One of the commonest shrubs and small trees especially in the stream valleys was a species of *Gonocaryum*, probably *G. melanocarpum* Hochr., on the dry slopes *Barringtonia* aff. *macrostachya* Kurz (putat) was very common.

Several herbs were very common in the stream valleys, such as *Homalomena rubra* Hassk and *Aglaonema schottianum* Miq., and one of the commonest ground ferns was *Tectaria singaporeana*.

It soon became noticeable that the number of different species on the island was very small compared with the tropical rain forest on the mainland. In a transect of 10 chains by 1 chain (200 m. x 20 m. = 1 acre) along the slope there were only 246 trees of 4 in. (10 cm.) diameter and over at breast height comprising only 30 different species, compared with an average of 226 trees comprising 102 different species in a similar plot

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at Bukit Lagong Forest Reserve, Selangor, and an average of 198 trees comprising 93 different species in a similar plot at Sungei Menyala F.R., Negri Sembilan. Thus although there appears to be in fact slightly more trees per acre, the number of different species represented is only a third.

Another noticeable feature of the vegetation was the patch distribution of many of the species, suggesting possibly recent colonisation or invasion of the island. Thus *Santiria laevigata* Bl. was only locally very common, being completely absent in parts of the island, the shrub *Adenosacme malayana* Wall was common in a small patch near the top of the hill, a species of *Ficus* was only noted as a clump of trees, as was also *Pipturus* ? *argenteus*. These may be new colonisers, seed possibly having been dropped by a flying fox or bird visiting the island.

In a small clearing caused by a windfall none of the usual secondary forest species of the Malay Peninsula, such as *Trema* spp., *Mallotus* spp., *Macaranga* spp., *Glochidion* spp. were found. The area was dominated by woody climbers, principally a species of *Arcangelisia*, and regeneration of the tree species and shrubs on the island.

In general ground flora was sparse, and the soil surface gave the appearance of being eroded, tree roots being exposed. This is not surprising in view of the steepness of the terrain. Some soil samples were taken from the top of the hill, half way down, and at the bottom of the slope near the sea coast. In all the organic content was found to be surprisingly high.¹ The soil at the bottom of the slope was very spongy, contained abundant undecomposed litter and was veering towards peat.

As complete a collection as possible was made of the different species comprising the vegetation. This amounts to approximately 55 trees, 11 shrubs, 12 climbers, 12 palms and herbs, and 16 ferns. Several lichens, mosses and fungi were also collected.

The most interesting point about the flora is the complete absence of the family *Dipterocarpaceae*, which in the Malay Peninsula is the commonest tree family. Further only two species were found of the family *Annonaceae*, one of the commonest families represented in the shrub and understorey layers in the Malay Peninsula, and one member of the *Sapotaceae* and *Burseraceae*.

The absence of *Dipterocarpaceae* and the paucity of woody species in a forest of apparent similar structure to that of the mainland strongly suggests that the flora is not a relict one, but a new one, namely that Pulau Jarak is an oceanic island.

1. Determined by the Soils Section of the Department of Agriculture, Federation of Malaya.

A very brief visit to Pulau Rumbia, the largest of the Sembilan Islands, and only 14 miles from the coast of the Malay Peninsula, revealed the presence of many of the species common on Pulau Jarak, 26 miles further out in the Malacca Straits. What proved most interesting however was the occurrence of several Dipterocarpaceae, viz: *Shorea maxwelliana* King (damar laut daun kechil), *Shorea multiflora* (Burck) Sym. (damar hitam), *Anisoptera curtisii* Dyer (mersawa kuning), *Dipterocarpus costulatus* V. Sl. (keruing kipas) and *Dipterocarpus? grandiflorus* Blanco. These species have all been reported from Pulau Pangkor, only a mile and a half from the mainland. The complete absence however of the 'red meranti' group of the genus *Shorea*, one species of which is common on Pulau Pangkor, *Shorea curtisii* Dyer ex King (seraya), raises the question of whether the Sembilan Islands are not also of oceanic origin, and suggests an interesting study for the future, especially as some of the coastal hills around Lumut on the mainland are but little higher than the Sembilan Islands.

The Animals

By J. L. HARRISON

A List of Species

The expedition was concerned primarily with Trombiculid mites and their hosts (which are usually mammals), and the invertebrates were not given the attention they deserved. However the species of animals were comparatively few, and if this list is not a complete record of the species present at the time of the visit, it is certainly an approximation to one. Acknowledgements for identifications are given, other identifications are the responsibility of the authors.

MAMMALS.

1. *Rattus rattus* jarak (Bonhote). The Jarak Rat.
Present in very large numbers, as described below. All specimens examined were infested with *Trombicula deliensis*, and many with *Walchia rustica* and Parasitoid mites not yet identified.
2. *Pteropus hypomelanus fretensis* Kloss. The lesser Flying Fox.
These were to be heard at night and were probably fairly numerous although none were seen by day. Two

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specimens shot were infested with Parasitoid mites not yet identified, and their stomachs contained figs. This subspecies is recorded only from Jarak and from Berhala, which is nearer to Sumatra; those from the Sembilan Islands differ in colour slightly.

It seems almost certain that no other mammals were present.

BIRDS.

3. *Haliaeetus leucogaster* (Gmel.).

Whitebellied Sea-eagle (det. B. D. Molesworth).

Three or four pairs were nesting in the trees of the ridge. Parasites were Mallophaga and Analgesid mites, not yet determined. The stomach contained fish remains and one whole fish.

4. *Ducula bicolor* (Scop.).

Pied Imperial Pigeon (det. B. D. Molesworth).

Present in large numbers, probably some hundreds, but no nests were seen. Several were shot and most were without infestation, some, however, bore Mallophaga, another species of Parasitoid mite, and several specimens of *Trombicula deliensis*.

5. *Eudynamys scolopacea* (L.). Koel (det. B. D. Molesworth).

One specimen seen and shot. No parasites. The stomach contained 5 seeds of a Myristicaceous plant.

6. *Locustella lanceolata* (Temm.).

Streaked Grasshopper Warbler (det. C. A. Gibson-Hill).

Only one specimen seen and shot. Parasites were analgesid mites not yet identified. This bird was conspicuous as one of the only two birds seen on the forest floor.

Other birds were seen, but no specimens were obtained, and since no member of the party claimed to identify birds at sight their identity must remain doubtful. They were:

7. A Reef Heron, perhaps *Demigretta sacra* (Gmel.). All were grey, and they frequented the rocks of the shore in pairs. There seemed to be from three to six pairs altogether.

8. One pair of brown hawks.

9. A blue Kingfisher, seen on several occasions flying over the sea (probably from headland to headland) some 50 m. out.

10. A pigeon (other than *Ducula*) was seen on the forest floor. Gibson-Hill suggests that this was likely to be the Nicobar Pigeon (*Caloenas n. nicobarica*).

11. An unidentified bird, not seen well, but said to resemble a Malkoha.

It seems unlikely that any other birds were present in significant numbers. The birds are discussed by Dr. Gibson-Hill in the paper following this one.

REPTILES.

12. *Mabuya multifasciata multifasciata* (Schneider).
(det. J. D. Romer).

A skink with an orange patch at the side of the body. The species is widespread along the coast and coastal islands. It was abundant on the forest floor, and many specimens had ticks (not yet identified) attached to the toes.

13. *Lygosoma atrocostatum* (Lesson). (det. J. D. Romer).

A rather dark coppery brown skink, also a widespread species. It was found only on the rocks of the shore, where it was common. Some specimens bore ticks on the toes.

One other skink was reported as seen once, it was described as pale brown with dark markings, but it is possible that this was but a colour variant of *Mabuya*.

14. *Gekko gekko* (L.). The Tuck-too Gecko (det. J. D. Romer).

These giant geckos were numerous and noisy. They were to be heard at all times of the day and night, and judging from the calls, were spaced on trees at intervals of about 100 m. A peculiarity about the *tucktoo* call was that the preliminary cackle was absent.

15. *Calamaria pavementata* Dum. and Bibr.
(det. M. W. F. Tweedie).

One specimen of this small retiring snake was caught among vegetable rubbish in the bed of the stream beside the camp.

CRUSTACEANS.

16. *Gecarcoidea humei* (Wood-Mason) Land Crab.
(det. M. W. F. Tweedie).

Present in very large numbers, see below. No ectoparasites were found on them.

17. One specimen of a Hermit Crab was seen, and collected, some twenty metres from the sea. Unfortunately the specimen was mislaid.
18. A woodlouse was seen, but not collected. It was not very abundant.

INSECTS.

Insects were chiefly remarkable for their absence. Most noticeable was the absence of Cicadas by day and Crickets by night. Only one small culicine mosquito was seen, but it was not a nuisance; nets were indeed used, but to keep off crabs and rats.

Small wood-boring beetles (Bostrychidae) were numerous, but termites were unusual, two species were indeed found, but the apparent slow decay of fallen trees showed that they were of minor importance. A few butterflies and two species of ants were noted.

OTHER INVERTEBRATES.

Small spiders were numerous and their webs everywhere. No large centipedes or millepedes were seen and only one small scorpion. No snails were seen. Earthworms were noted twice.

The Jarak Rats

Rats were present in enormous numbers. Their activity began between 5 and 6 p.m. that is before it was dark, and judging from the scurrings around our beds, continued all night. They were rarely seen during the day, although on one occasion two were seen and heard at 3 p.m. on a sunny afternoon quarrelling over the remains of a dead crab in an exposed position on the rocks of the shore. The ground was liberally burrowed—in some places almost honeycombed—but all the holes examined seemed to be those of crabs. Rats were disturbed among the roots of trees on several occasions however. There seemed to be no significant tree-climbing; traps in trees caught rats only when set low (up to 2 m.) in trees which could be climbed easily; traps set high in trees (6–10 m.) caught nothing at all.

About two hundred rats were trapped, and most of these were killed, examined for parasites, and measured. Most of the rats were trapped in three areas (a) a sample area immediately west of the camp (Site 2), (b) at the highest point, and (c) at site 3 a former camp site where scrub typhus had been contracted.

All the rats were very bold. They were deliberately encouraged in the camp by leaving foodstuffs about, but little encouragement was needed (Plate 6). They seemed to take little or no notice of humans moving in their vicinity, and if the observer stayed still they would frequently run over his body. So unafraid were they that they could be tickled while feeding, and after a slight initial surprise, they seemed to enjoy the experience. Their chief enemies seemed to be other rats and fights over feeding were incessant.

Every rat was heavily infested in the ears with the scrub-typus mite *Trombicula deliensis*, and many bore the white *Walchia rustica* around the lips, and some Parasitoid body mites. Many of the rats were losing hair from their backs, some being almost bald (Plate 6). The condition was not investigated closely, but it seemed to be a dietary deficiency. No mange mites were found.

Many of the rats, especially those from the camp area (Site 2) were heavily parasitised with worms. All from the camp area had large masses of eggs in the liver, masses which sometimes took up as much as nine tenths of the volume of the liver.

Abundance.

In order to get some rough idea of the abundance, an attempt was made to trap out one small area 20 metres square by laying 30 traps in it each night. The catch of rats and crabs is shown in table 1. On the first night in fact an area of twice the size was laid with 60 traps, and half this catch is shown in the table. There was no reduction in the number of rats after six days, and the test was discontinued.

Table 1

Rats and crabs caught in 30 traps set inside a square of 20 m. side.

Day of Trapping	Number of Rats	Number of Crabs
1	15	5
2	10	3
3	15	1
4	17	4
5	6	6
6	14	1
Total	77	20
Mean	13	3

Such results do not justify any incursion into the realms of higher mathematics in order to calculate the density of population, but they do give a vivid impression of how great that density must have been. The trapping rate in the area works out at 43 per cent trap-nights¹; the rate for average conditions on the mainland being only about 10 per cent. The rate was thus over four times as great as that on the mainland, and the population density to maintain this rate must have been much more than four times the mainland density. There are two reasons for this: firstly the traps were here set much more closely than in average mainland conditions and therefore sampled a smaller area, secondly so many traps caught rats that many rats which otherwise would have been caught must have met traps already occupied. It seems reasonable therefore to postulate a population density of from ten to twenty times that of the mainland. Marking experiments (unpublished) suggest a population of over ten rats per hectare in grassland with scrub in Selangor, which would imply a density of between one and several hundred per hectare on Jarak.

Most of the rats were caught early in the evening, indeed it seems likely that comparatively few crabs were trapped largely because by the time it was dark enough for the crabs to become active a large proportion of the traps already contained rats. As a first approximation therefore it seems reasonable to take the average number of rats trapped each evening as the number using that area at the beginning of the evening, rats not trapped being counterbalanced by rats coming in from outside the area to be trapped later in the night. This gives an average population of 13 rats in the 20 m. square or 320 rats per hectare.

A population of at least 200 rats per hectare (80 per acre) seems a reasonable estimate. Taking the island as 30 hectares this means a total population of at least 6,000 rats if the population was of uniform density. That the density was substantially uniform is suggested by the fact that rats were equally easy to trap wherever it was tried.

Structure and Relationships.

Rattus jarak was described by Bonhote (1905) on the basis of a single specimen sent by Robinson. Bonhote considered that it was allied to *Rattus mülleri*, but Robinson (1916) later examined a long series of rats collected in 1915 and decided that it was a form of the cosmopolitan *Rattus rattus*.

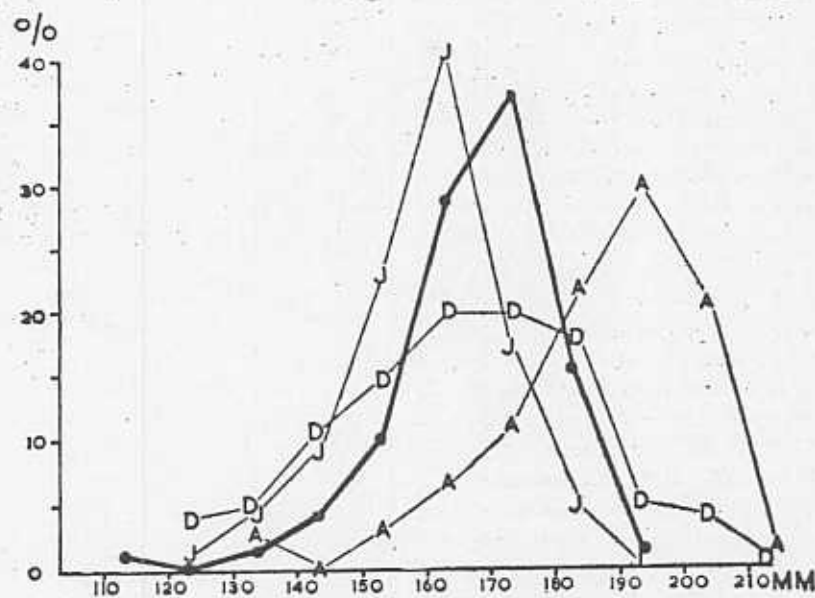
On the mainland *Rattus rattus* exists in three forms, *R. r. jalorensis*, *diardi*, and *argentiventer*, and the principal dimensions of these three forms are compared with the Jarak rats in Table 2 and Figs. 2, 3, 4 and 5.

¹ Per cent trap-nights: number of rats caught per hundred traps per night over the whole period.

Table 2

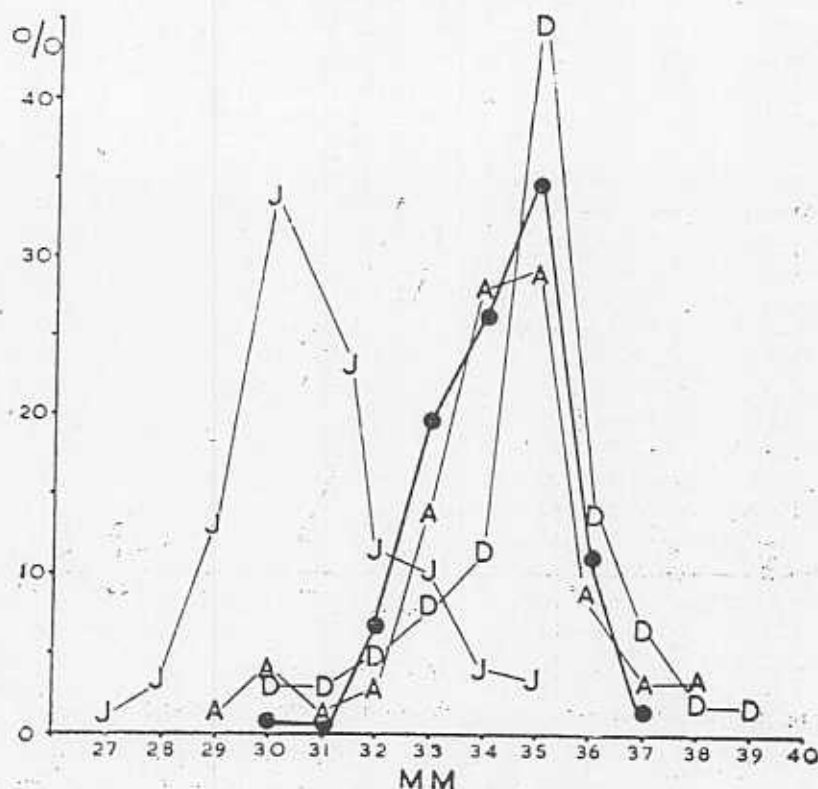
A comparison of the principal dimensions of the skulls of short random series (10 each) of rats from Jarak and of rats of the three mainland forms of *Rattus rattus*. For each dimension is given the mean and the standard error of the mean (mm.)

Rat	Occipito-nasal length	Palatal length	Diastema length	Upper cheekteeth	Anterior palatal foramen	Bulla length
<i>Rattus rattus</i>						
Jarak	39.3±0.40	21.3±0.25	10.8±0.20	6.4±0.08	6.6±0.14	6.3±0.03
jalorensis	40.9±0.51	22.0±0.28	11.3±0.23	6.6±0.06	7.2±0.13	7.0±0.06
diardi	40.8±0.78	22.0±0.39	11.1±0.30	6.9±0.12	7.4±0.14	7.0±0.10
argenteiventer	41.1±0.53	22.3±0.22	11.3±0.20	7.2±0.09	7.7±0.17	7.5±0.12



Jarak rats: Frequency polygon comparing body lengths

Fig. 2. Lengths of head and body, nose to anus, in mm. for whole sample of male Jarak rats (thick line) and for samples of adult males of three mainland forms of *Rattus rattus* (lettered thin lines) J—J *jalorensis*, D—D *diardi*, and A—A *argenteiventer*. Lengths are grouped at 10 mm. intervals, and the vertical scale represents the percentage of the sample in that group.



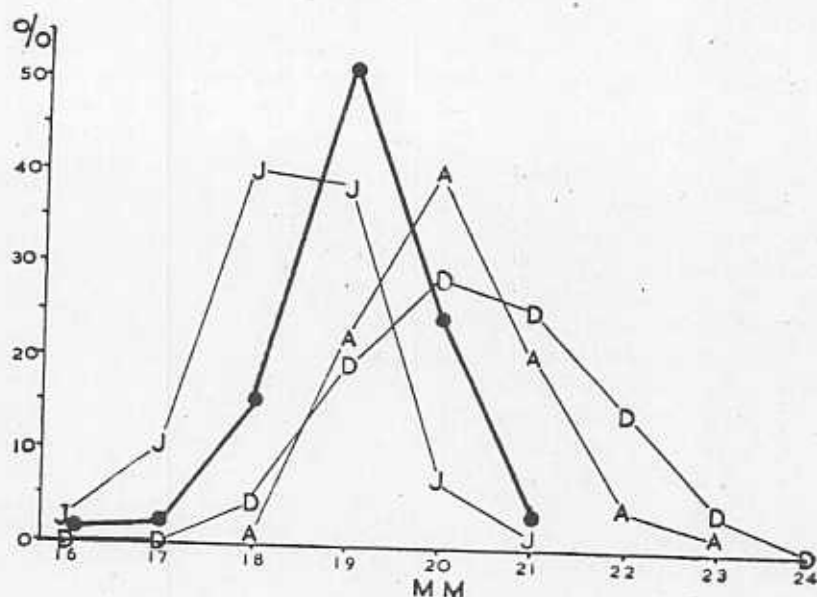
Lengths of hindfoot compared

Fig. 3. Lengths of hindfoot, without claws, in mm. for male rats, whole sample from Jarak and adults of the three mainland forms.

R. r. jalorensis occurs in forest, open woodland, and as a pest on Oil Palm estates. It is smaller than the other forms, especially in the length of the hindfoot, and the belly is typically white or creamy white with an occasional buff patch on the throat or in the centre line. The mammae are $2+3=10$.

R. r. diardi is a town rat and is confined to houses or their immediate vicinity. It is larger than *R. r. jalorensis* in every way, and the belly is typically brownish grey, but this colouring is very variable and specimens may be found in the same population with bellies of all colours from dark grey to almost white. The mammae are $2+3=10$.

R. r. argentiventer is a rat of open grassland (*lalang*) and ricefields. Specimens average slightly larger than *R. r. diardi* and the colour of the belly is invariably a pale silvery-grey. The mammae are $3+3=12$.



Lengths of ear compared

Fig. 4. Lengths of ear, from notch to tip, in mm., for male rats as above.

The Jarak rats are small, of the same order of size as *R. r. jalorensis*, but they differ significantly from that form. The Jarak skulls are actually smaller than those of any of the mainland forms, and, allowing for a difference in age distribution, the body lengths and weights of the Jarak rats approximate to those of *R. r. jalorensis*. Although the skulls average smaller than *R. r. jalorensis*, the ears average slightly longer than those of that form, although shorter than those of *diardi*. The hind-feet are clearly longer than those of *R. r. jalorensis* and approximate to those of *diardi* and *argenteventer*. The Mammae of the Jarak rats were all $2+3=10$ and therefore resembled *R. r. jalorensis* and *diardi* and differed from *argenteventer*.

In colouring the Jarak rats resembled *R. r. diardi* in having a brown dorsum and a venter showing any shade of brown or grey to nearly white. In this respect they differed from Bonhote's type which he describes as having underparts 'pure white'. The colour of the underparts of some of our specimens approximated to white, and it is possible that he was sent an extreme variant.

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The Jarak rats differed from all typical mainland forms in having a generous admixture of soft spines among the dorsal hair. The presence or absence of spines, however, is so variable a character among the rats that no special importance need attach to it.

Rattus jarak, then, resembles *Rattus rattus diardi* more closely than any other form. It differs in having a smaller maximum size, and in particular a smaller head. The colony on the island was grossly overcrowded and diseased, and it seems possible that the average size-difference was nothing more than a reflexion of malnutrition and disease in a colony of rats which would otherwise be considered typical *R. r. diardi*. The small size of the colony, say 6,000 to 10,000, and the range of variation, within that of *R. r. diardi* but with different means, suggests however an example of the Sewall Wright effect of drift (Wright 1939). Probably both factors are operative.

Tail Damage.

The length of the tail has been omitted from the previous discussion because of the likelihood of bias in averaging a population containing so many damaged tails. The proportions are compared with the proportions in wild populations of other forms in table 3. The fact that the proportion is so much higher than that of any other form is probably due both to the average age of the rats, which is discussed below, and the overcrowding. It is noticeable that the only rats with comparable proportions of damaged tails are the males of the town and the oil-palm rats, both of which populations are dense but not overcrowded. It seems likely that fighting is the cause of the damage, due to sexual rivalry among males of the mainland forms but due to competition for food on Jarak.

Table 3

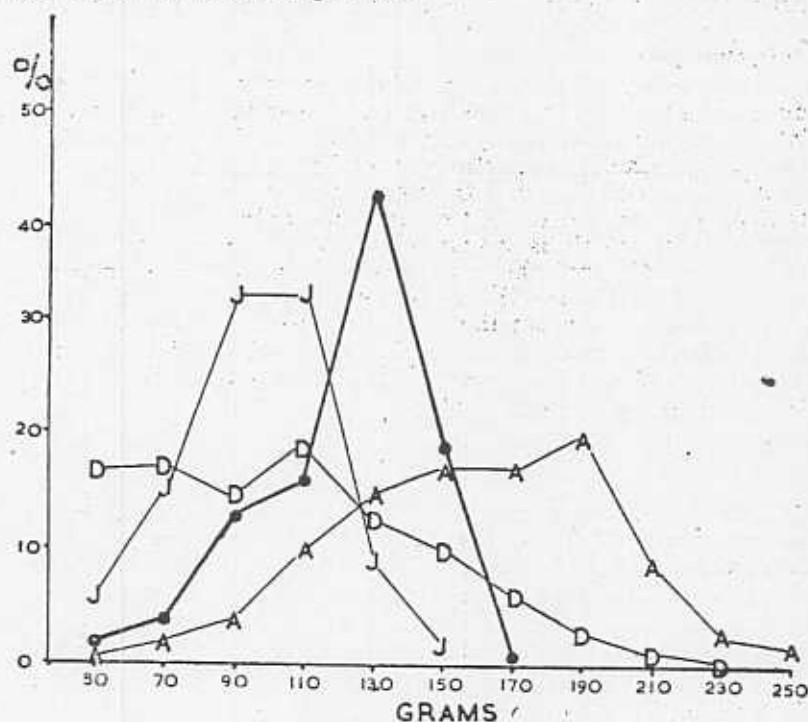
Proportion of damaged tails among rats from Jarak and among adults of three populations of *Rattus rattus* from the mainland.

Rat population	Percentage with damaged tails	
	♂♂	♀♀
<i>Rattus rattus jarak</i>	18	17
<i>R. r. jalorensis</i> from an Oil Palm estate ..	11	2
<i>R. r. diardi</i> from Kuala Lumpur town ..	13	6
<i>R. r. argentiventer</i> from Selangor waste land	3	4

Age distribution.

Fig. 5 shows that the weight distribution was unusual in that there were very few rats of under 70g and the biggest

concentration of weight was near the maximum. This distribution is very different from that of *R. r. diardi* from Kuala Lumpur town in which the maximum number of rats is in the smallest weight groups, and the proportion declines with increasing weight. *R. r. jalorensis* is intermediate in this respect. Rats increase in weight with age over a long period, and it is possible to use the weight to form an estimate of the age distribution of a population as has been done by Harrison and Woodville (1950). At present there are no very good estimates of the weights of these rats at ages, but guessing from incomplete information we may say that *R. r. diardi* males weigh about 60g at two months, 90g at 3 months and 120g at 4 months. The proportion of the rats below these and other weights are shown in table 4. Only rats over 40g are considered because rats much smaller than this are likely to escape through the mesh of the standard traps used.



Body weights of Jarak and mainland rat populations
 Fig. 5. Body weights in grams, grouped by 20 g. intervals, for all male rats of 40 g. and over from Jarak (thick line), town (*R. r. diardi* D—D), Selangor waste land (*argentiventer* A—A), and an Oil Palm estate (*jalorensis* J—J).

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Table 4

A comparison, for three populations, of the proportions of all rats of weight 40g and over which were less than the weight shown. The approximate ages of *R. r. diardi* at certain weights is indicated, other rats, averaging lighter, will be younger at these weights.

Body weight in grams	Percentage of all male rats (over 40 g.) below this weight		
	<i>R. r. jarak</i> from Jarak	<i>R. r. diardi</i> from town	<i>R. r. jalorensis</i> from Oil-Palm estate
60	2	17 (2 months)	7
70	3	26	12
80	6	34	23
90	15	42 (3 months)	37
100	20	49	55
120	36	68 (4 months)	89
140	80	81	97
160	99	90	c100
180	100	96	100
200	—	99	—

The age estimates given are for those of *R. r. diardi*, the other rats, being smaller, will be somewhat lighter at those ages, and the proportion of rats below that age will be accordingly over-estimated. It is clear that the *R. r. diardi* population is predominantly a young one, with over two thirds of the rats younger than 4 months. The jarak population however is predominantly an old one with at least two thirds of the rats older than 4 months.

Pregnancy.

Of 88 females examined 10 were pregnant, all with either two or three embryos. The resulting estimates of reproduction rate are shown in table 5 compared with corresponding figures for the mainland forms of *R. rattus*. The figures being compared as potential reproduction rate are actually the number of embryos per hundred adults. To convert this figure to a true reproduction rate it would be necessary to know the gestation period and the intra-uterine mortality. However it is clear that the reproduction rate of the Jarak rats was very low. It is possible of course that this was merely a seasonal variation, but a low reproduction rate is consistent with the low death rate needed to maintain a predominantly aged population.

Table 5

A comparison of the fertility of populations of the four forms of *Rattus rattus*.

Form		<i>jarak</i>	<i>diardi</i>	<i>jalorensis</i>	<i>argentiventer</i>
Locality		Jarak	Town	Oil Palm	Waste Land
Mean pregnancy rate	..	11%	20%	20%	5%
Mean embryo number (emb. per pregnant ♀)	..	2.5	5.7	3.8	4.2
Mean embryo rate (emb. per 100 all ♀ ♀)	..	28%	114%	76%	21%
Sex ratio, ♂ ♂ per 100 ♀ ♀	..	110	75	105	135
Potential reproduction rate (emb. per 100 all adults)	..	13%	65%	37%	9%

Summary.

The jarak rats show very close affinities to the house rat, *Rattus rattus diardi*, of the mainland, rather than any other mainland form. They differ principally in their smaller maximum size.

The Crabs

The crabs were almost as numerous as the rats, and they occurred in every part of the island right up to the highest point. They lived in burrows in the soft peaty soil or among tree roots. The burrows were of a characteristic semi-circular cross section and usually contained what appeared to be droppings. These were little twig-like rods some two millimetres in diameter and up to 4 cm. long, of a dark brownish-grey colour and of the consistency of partly-dried putty.

The crabs did not become active until it was completely dark, and could thus be watched only by artificial light, which made them retreat to their holes. They were seen nibbling at leaves and dragging them away to their holes, subsequently specimens in captivity lived for a time on a diet of green vegetables from the Kuala Lumpur Markets. They frequently entered the traps set for rats, but they did not seem to eat the coconut bait.

Although numerous and active they seemed to have no great range of movement, thus the destruction of a dozen crabs left our tent free of them, although those 20 m. away were left untouched. It seems likely therefore that the twenty specimens caught in the traps set for rats in the test area of 20 m. square (Table 1) were drawn from an area of not more than 1,000 m² which argues a population of at least 200 per hectare.

Crabs of this species are said to make an annual mass-migration to the sea for spawning (Gibson-Hill 1947). There is no evidence of the time of the year when this phenomenon occurs on Jarak.

A Note on the Crabs

By M. W. F. TWEEDIE

WOOD-MASON 1873, p. 258 (*Hylaeocarcinus humei*).
TWEEDIE 1947, p. 37; 1950, p. 93.

Gecarcoidea humei (Wood-Mason).

Three specimens of this land crab, taken on Pulau Jarak, were sent to me by Mr. Harrison.

I have remarked (ll.c.) on the possibility of defining geographical races on the three characters: spinulation of the ambulatory dactyli, proportions of 6th male abdominal segment and development of scar-like markings on the carapace. The ambulatory dactyli bear six rows of spines, an anterior and posterior pair and single rows on the upper and lower surfaces; for convenience the spines on the superior single row are counted, a total of spines on all eight legs being taken as an index. A numerical expression can be given to the first two characters and if tabulated for the four localities from which I have examined material they give the following result.

	<i>a</i>	<i>b</i>
Christmas Island (<i>G. h. natalis</i>)	.. 33	1.63
Andaman Islands	.. 78	1.75
Pulau Jarak	.. 93	1.85
Aor Island, S. China Sea	.. 135	1.82

a is the average of the number of spines on all eight of the superior dactylar rows and *b* the median length: basal breadth ratio of the 6th male abdominal segment. Except in the case of *natalis* these averages are obtained from series of two or three specimens, and no taxonomic recognition can be based on them. The "scars" on the specimens from Pulau Jarak are larger than those of the Aor form, much smaller than those of *natalis* and probably not significantly different from the condition in the topotypical form.

The Parasites

By J. R. AUDY

A major object of the visit to Jarak was to determine the vector of scrub typhus on the island, and to gain information on the numbers, distribution, and habitat, of all the ectoparasites which may have been present on the rats. A second object was

to discover what parasite was responsible for the attack of "scrub-itch" reported by Mr. Ensoll. All animals collected were searched for parasites as a routine, but the rats were the hosts of greatest importance.

Trombiculid Mites

Only two species of Trombiculidae were found, *Trombicula deliensis* Walch, 1922, the vector, which was present on every rat examined, and *Walchia rustica* Gater, 1932, which was occasionally present. Both were found in the parasitic larval form; a number of soil samples were washed in a casual effort to find nymphs and adults, but none were so found.

Trombicula deliensis.

Larvae of the vector were found in the usual site of election, clustered deep in the ears of the rats. Every rat trapped was inspected for mites, and every one was found to be infested. Complete collections were made from samples only: from the stream-side camp (site 2) 49 rats carried 11,415 larvae (average 233 per rat); from the streamside area at site 3, 26 rats carried 5,085 mites (196 per rat); and from High Point, 37 carried 6,660 (180 per rat). High point is presumably in general drier than sites 2 or 3, but at the time of collection this difference was clearly not great enough to be reflected in a significantly smaller mite population as our mainland experience would lead us to expect. The collection was however made in rainy weather; it is probable that during dry spells a fall in larval population would first be observable at such a place as High Point or the more exposed northwest flank of the island.

Tables 6 and 7 compare the standard measurements of a sample of *T. deliensis* from Jarak with those of samples from an oil palm estate near Kuala Lumpur and of samples of the form *walchi* and of a pool of *T. deliensis* from four different areas of New Guinea and Queensland, data from Womersley (1944). As Womersley has inferred from his data, *T. deliensis* is a very variable species. The Jarak form differs in several features from the mainland form which has been sampled, the most noticeable feature being a shallower posterior scutal depth (PSB) which has the effect of making the posterior margin of the Jarak form more sinuous and, in particular, concave instead of convex immediately adjacent to the postero-lateral (PL) setae. The differences between the Jarak and the mainland forms are no greater than those which may be found between collections from different areas of the mainland. Populations of these mites may often be effectively isolated from one another

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on the mainland. The measurements given in table 6 are not strictly comparable item by item since the different samples were measured by different observers, the Jarak sample by the author and the mainland sample by Mr. M. Nadchatram.

Table 6

Standard dimensions of samples of T. deliensis from Jarak and the mainland. Samples from Jarak and from an Oil Palm estate measured in this laboratory (by two different workers). Standard measurements, in microns, are of various dimensions of the larval scutum, the objects measured and the abbreviations used are as set out in Womersley and Heaslip (1943).

Dimension	Mean (m) $\pm$ standard error of mean	Standard deviation (s)	"Theoretical range" $m \pm 3s$	Observed range	Coefficient of variation $\frac{s}{m} \times 100$
13 specimens from Jarak					
AW ..	57.6 $\pm$ 0.57	2.13	51.2-64.0	53.0-61.0	3.7
PW ..	68.9 $\pm$ 0.57	2.05	62.8-75.1	65.0-71.0	3.0
SB ..	27.1 $\pm$ 0.38	1.38	23.0-31.2	24.0-28.0	5.1
SD ..	36.9 $\pm$ 0.52	1.89	31.2-42.6	35.0-40.4	5.1
A-P ..	26.9 $\pm$ 0.35	1.25	23.2-30.7	25.0-29.4	4.6
AM ..	47.8 $\pm$ 0.57	2.06	41.6-54.0	45.0-50.4	4.3
AL ..	41.9 $\pm$ 0.64	2.30	35.0-48.8	40.0-46.0	5.5
PL ..	47.7 $\pm$ 0.58	2.10	41.4-54.0	45.0-50.6	4.4
Sens ..	65.0 $\pm$ 0.76	2.74	56.8-73.2	60.5-70.0	4.2
15 specimens from an Oil Palm estate, Selangor					
AW ..	58.8 $\pm$ 0.64	2.47	51.4-61.2	54.5-66.0	4.2
PW ..	70.3 $\pm$ 0.39	3.44	60.0-80.6	64.2-79.0	4.9
SB ..	27.9 $\pm$ 0.34	1.32	23.9-31.9	25.7-30.0	4.8
SD ..	38.8 $\pm$ 0.66	2.54	31.2-46.4	36.2-42.0	6.6
A-P ..	26.9 $\pm$ 0.40	1.54	22.3-31.5	24.6-29.5	5.8
AM ..	50.6 $\pm$ 1.56	6.02	32.5-68.7	44.3-58.0	11.9
AL ..	40.8 $\pm$ 1.19	4.61	27.0-54.6	34.4-49.0	11.3
PL ..	55.3 $\pm$ 1.64	6.34	36.3-74.3	45.0-64.0	11.5
Sens ..	60.0 $\pm$ 1.21	4.67	46.0-74.0	52.8-67.0	7.8

Table 7

Standard Dimensions of T. deliensis from New Guinea and Queensland. Data from Womersley 1944 of specimens of the form *walchi* from New Guinea and of a pool, of typical *deliensis* from New Guinea and Queensland, for comparison with data in table 6. Full statistics are given in the paper referred to.

Dimension	Mean (in microns) $\pm$ standard error of the mean		
	<i>T. d. walchi</i>	<i>T. deliensis</i>	S.S.
	16 specimens		
AW	60.5 $\pm$ 0.36	65.9 $\pm$ 0.50	
PW	68.2 $\pm$ 0.55	80.3 $\pm$ 0.80	
SB	28.7 $\pm$ 0.23	31.3 $\pm$ 0.31	
SD	38.5 $\pm$ 0.68	39.0 $\pm$ 0.37	
A-P	26.7 $\pm$ 0.62	29.4 $\pm$ 0.26	
AM	43.1 $\pm$ 0.86	56.0 $\pm$ 0.74	
AL	35.0 $\pm$ 0.36	44.0 $\pm$ 0.63	
PL	42.4 $\pm$ 0.96	63.3 $\pm$ 1.20	
Sens	60.3 $\pm$ 0.65	64.2 $\pm$ 0.52	

It was not our intention to investigate degree of infection with scrub typhus on this reconnaissance visit. Nevertheless about 300 larvae from rats were inoculated into white mice by Dr. S. R. Savoor, Senior Pathologist of the Institute for Medical Research, but with negative result. In the circumstances this negative result is surprising, a near saturation of infection might well have been expected.

A few specimens of *T. deliensis* were recorded from an Imperial Pigeon. This finding is not unexpected, but since these particular specimens were not inspected and confirmed as they were taken off the bird, the record is not a certain one.

Walchia rustica.

Numbers of white larvae of this species were found along and below the edge of the lower lip of several rats. Some of these larvae remained feeding for 17 days after the host rat had been brought back to the laboratory. Accurate infestation data cannot be given because, the larvae being in an unexpected position, many of the infestations on the earlier rats seen must have been missed. It is clear, however, that these larvae were present on a relatively small proportion of the rats, but the number present on those rats which were infested was considerable (e.g. over 50). There must be good reasons, probably connected with soil conditions, why this species has not spread more widely among the rats. No particular importance could be attached to the recovery of infection from such a mite in the presence of such large numbers of the established vector, and therefore no attempt was made to recover it.

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Attempts were made by Mr. K. L. Cockings to rear the engorged larvae through to adults by methods which have proved very successful with *Trombicula deliensis*, but all the nymphs died.

This mite is only occasionally to be found on rats from the mainland. It is however very closely related to a very widespread species *W. turmalis* Gater.

Parasitoid Mites and Ticks

Ectoparasites other than trombiculids were collected by beating and combing, but no other special techniques were used. About a third of the rats bore Parasitoid mites of at least two species. A relatively small number of large mites were present and were identified as *Echinolaelaps echidninus* (Berlese), an almost cosmopolitan species. A smaller species, yet to be identified, was much more numerous, but even so the average number of parasitoids was only about three per rat. *E. echidninus* occurred in very small numbers and the failure of this nest-infesting species to become populous suggests that the rat may not spend much of its time in protected nests.

Larval and post larval stages of a so far unidentified tick (Ixodidae) were found attached to several of the skinks, both *Mabuya* and *Lygosoma*. These skinks were very numerous and the number of ticks present on the island may be quite high. As no scrub-itch mites were found on Jarak it may have been that Mr. Ensoll was attacked by larval ticks, in which case however it is difficult to account for the absence of ticks from the rats.

All of these specimens have been passed to Major R. Traub, Ph.D., M.S.C., A.U.S., for identification.

Other Ectoparasites

An occasional louse (? *Polyplax spinulosus*) was found on the rats. The failure of this parasite to thrive again suggests the absence of proper nest making by the rats. Unidentified analgesid mites and Mallophaga were found on several of the birds, as noted in the list of animals. Many of the birds may have been migrants and their infestations therefore cannot be directly related to the island.

Endoparasites in the Rats

The rats were freely infested with several worms, specimens of which have been sent to Professor J. J. C. Buckley at the London School of Hygiene and Tropical Medicine. Only a few rats could be examined owing to pressure of time. Cestodes

were found in several rats in the first seven inches of the gut, and a large nematode with two rows of spines was fairly common in the stomach, first few inches of the gut, and the common bile duct, apparently penetrating to the liver. The most striking infestation however was by a worm, reddish in colour, apparently adult forms of which were found in the liver substance and, on one occasion, in a cluster in the portal vein. The males of this worm possessed copulatory bursae and it was therefore assumed to be a strongyloid. In two rats enormous numbers of strongyloid worms were found in or on the mucosa of the first foot or so of gut; these were dark red in colour and were generally coiled into tight helices.

Nematodes were responsible for gross lesions in the liver, containing vast numbers of eggs in masses.¹ At least two species of nematode, the strongyloid and the peculiar spined form, were definitely found in the liver, but the former appeared to be more regularly associated with the lesions. Early lesions appeared below the surface of the liver as small yellowish bodies becoming serpuliform and then coalescing and finally forming solid yellow masses, entirely composed of eggs, and sometimes projecting slightly above the surface. The liver substance was more or less congested. In our camp area (site 2) every rat examined showed lesions visible to the naked eye, and about a third of them showed gross lesions, in some cases reducing the liver substance to perhaps a tenth of its normal volume. Rats from site 3 however showed very much less infestation, several appearing quite free from the egg masses and the others showing only small lesions. It seems probable that infestation by worms is one of the most powerful of the factors influencing the development of the rat colony on Jarak.

Conclusions

By J. L. HARRISON

In the section on vegetation, Mr. Wyatt-Smith points out that the flora is of an oceanic type, and quotes in evidence: the number of species per unit area; the incomplete distribution of individual species, pointing to recent introduction; and the absence of whole groups of common plants. A similar state of affairs obtains with the animals.

1. According to a preliminary note from which Professor Buckley has kindly allowed me quote information, the masses of eggs in the liver are from *Hepaticola hepatica*, the adults of which were strangely enough not found. The strongyloids in the portal system of the liver (a most unusual habitat for a bursate nematode) are probably of a new species. The large spiny nematodes are a species of *Rictularia* and the red strongyloids in the gut a species of *Nippostrongylus*.

Number of Species.

The terrestrial vertebrates of Malaya comprise over 450 species, about 110 mammals (excluding bats) and 350 reptiles and amphibians. Jarak seems to possess one terrestrial mammal and 4, perhaps 5, reptiles. It is not easy to estimate how many species to expect on a thirty hectare area of forest, but it would certainly be more than this. Mammals collected over about 25,000 hectares (100 square miles) of mixed country in Selangor comprised 8,247 specimens of 49 species, and the abundance of different species form a logarithmic series of index of diversity of about 7 (Williams 1947). A random sample of 200 specimens of this collection would comprise about 23 species; the discrepancy between this estimate and the single species of the 200 rats collected on Jarak is obvious.

Absence of common groups.

Even allowing for the fact that Jarak would be too small to support any of the larger animals, and that predators, if ever present, might die out during violent population fluctuations, there is abundant room, both geographically and ecologically, for animals of several groups. There were no squirrels, and nothing to fill the niche they would occupy, no snails, and no millepedes. Although both ants and termites were seen, the species present did not seem adequate to fill the niches they usually occupy. In particular, tree trunks seemed to be disintegrating much more slowly than they do in typical mainland forest. It is inconceivable that all these niches should have been occupied at some time, and that the animals should have died out.

Method of introduction.

The conclusion therefore is that the island must at some time have been bare, or virtually bare, and that subsequently colonisation has been entirely by chance introduction. Mr. Wyatt-Smith hopes to analyse the possible means of introduction of the plants in a later paper, but it was obvious that many were of the types readily transported by birds or by the sea.

The three lizards and the snake could have been transported on floating vegetational debris, of which samples were found cast up on the shore. Such an introduction must be rare, but it is not asking too much that it should have occurred for four of the most likely species. The gecko is a tree dweller, and would probably cling to its tree were that swept out to sea. The skinks are both species common on the shore of the mainland opposite, and they are likely to venture out onto floating debris which is temporarily stranded. The snake is likely to venture into tangled masses of flood-debris which may be subsequently refloated and swept out to sea.

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SURVEY OF JARAK ISLAND

PLATES

(Between pages 232 and 233)

PLATE 5. The shore of Jarak.

A general view of the shore at site 2 (campsite, and where a stream enters the sea), taken from a boat. The huge boulders (c.f. man right) are overhung by the fresh-water-loving *Hibiscus tiliaceus*, through which a path has been cut to the small clearing centre; otherwise the vegetation cover is unbroken.

PLATE 6. Rats feeding in camp on Jarak.

A flashlight photograph of part of the kitchen tent about 3 m. from where members of the party were seated at dinner. Rats are eating spilt rice, and the centre one shows typical bald patches.